

Remarks

Claims 1-11 are pending, and claims 1-11 stand rejected. Claims 1-2, 4, 6-7, and 9-11 are amended by this amendment. Applicants respectfully traverse the rejection and request allowance of claims 1-11.

The objections and rejections cited on pages 2-3 of the office action are moot in light of the amendments to the claims, drawings, and specification.

The Examiner rejected claim 1 under 35 U.S.C. § 102 as being anticipated by U.S. patent 5,394,758 (Wenger). Wenger teaches a flow meter (1) comprised of flanges (19, 20), flow tubes (11, 12), brace bars (32, 33), a driver (16), and pickoffs (17, 18) (FIGS. 1-2; column 3, line 58 thru column 5, line 17). The flow tubes are loops that have straight portions (111, 112) and a curved portion (FIGS. 1-2; column 3, line 66 thru column 4, line 12).

Wenger does not teach a first flow tube having an inlet end and an outlet end, said first flow tube forming a substantially semicircular arc between said inlet end of said first flow tube and said outlet end of said first flow tube. Wenger also does not teach a second flow tube having an inlet end and an outlet end, said second flow tube forming a substantially semicircular arc between said inlet end of said second flow tube and said outlet end of said second flow tube. Wenger in fact teaches the opposite. Wenger teaches flow tubes that have straight portions (see FIGS. 1-2). A flow tube with a straight portion cannot form a substantially semicircular arc between an inlet end and an outlet end as described in two limitations in claim 1.

Wenger also does not teach pick-offs affixed to said first flow tube on said substantially semicircular arc of said first flow tube and said second flow tube on said substantially semicircular arc of said second flow tube. Instead, Wenger teaches the pickoffs be placed on the straight portions of the flow tubes (FIGS. 1-2; column 5, lines 3-17).

A commercial advantage of claim 1 over Wenger is that the flow meter in claim 1 has smaller dimensions than the flow meter in Wenger. The substantially semicircular arc shape of the flow tubes of the flow meter in claim 1 allow for the smaller dimensions instead of the tube loops that have straight portions as in Wenger. The smaller dimensions allow the flow meter in claim 1 to be used in smaller areas.

For the above reasons, claim 1 is allowable over Wenger. Claims 2-11 are allowable as being dependent on claim 1.

The 35 U.S.C. § 103 rejections on pages 6-7 of the office action are moot in light of the above arguments.

The Applicants submit that there may be additional reasons in support of patentability, but that such reasons are moot in light of the above remarks and are omitted in the interests of brevity. The Applicants respectfully request allowance of claims 1-11.

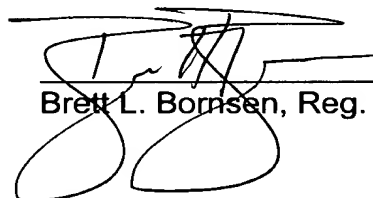
The Applicants believe that no fees are due. However, any additional fees may be charged to deposit account 03-1725.

Respectfully submitted,

Date: 10-5-01

Tel. No.: 303-546-1300
Fax No.: 303-499-5426

CORRESPONDENCE ADDRESS:


Brett L. Bornsen, Reg. No.: 46,566

Customer No.: 28286

Version with Markings to Show Changes Made

In the Specification

The following represent marked-up versions of the amendments made to the specification.

The paragraph on page 1, beginning on line 4:

This invention relates to Coriolis flowmeters. More particularly, this invention relates to reducing a flag dimension of a Coriolis flowmeter by using flow tubes having a substantially semicircular arc and one set of brace bars. Still more particularly, this invention relates to a configuration of components that maintains zero stability and reduces the amplitude of the vibrating flow tubes to reduce stress applied to the brace bars.

The paragraph on page 1, beginning on line 12:

It is known to use Coriolis effect mass flowmeters to measure mass flow and other information of materials flowing through a pipeline as disclosed in U.S. Patent Nos. 4,491,025 issued to J.E. Smith, et al. of January 1, 1985 and Re. 31,450 to J.E. Smith of February 11, 1982. These flowmeters have one or more flow tubes of a curved configuration. Each flow tube configuration in a Coriolis mass flowmeter has a set of natural vibration modes, which may be of a simple bending, torsional, or coupled type. Each flow tube is driven to oscillate at resonance in one of these natural modes. The natural vibration modes of the vibrating, material filled system are defined in part by the combined mass of the flow tubes and the material within the flow tubes. Material flows into the flowmeter from a connected pipeline on the inlet side of the flowmeter. The material is then directed through the flow tube or flow tubes and exits the flowmeter to a pipeline connected on the outlet side.

The paragraph on page 3, beginning on line 17:

The above and other problems are solved and an advance in the art is made by the provision of a Coriolis flowmeter having a reduced flag dimension in the present invention. The Coriolis flowmeter of the present invention has flow tubes

that are capable of handling large mass flow rates. The Coriolis flowmeter of the present invention does not have a conventional manifold and spacer. Instead, the spacer [is] substantially surrounds the manifolds. This configuration reduces the cost of the flowmeter. The Coriolis flowmeter of the present invention also has a reduced flag dimension which allows the Coriolis flow meter of the present invention to be used in areas where space is at a premium and it would be impossible to use a conventional Coriolis flowmeter having a conventional flag dimension.

The paragraph on page 3, beginning on line 32:

A driver is affixed to the flow tubes at a position along the semicircular arc of each flow tube that is substantially perpendicular to a plane containing the inlet end and the outlet end of the flow tube. The driver is positioned at this point to minimize [maximize] the amount of energy applied to the flow tubes by the driver to cause the flow tubes to oscillate. Drive signals are applied to the driver to cause the driver [drive] to oscillate the flow tubes at a low amplitude to reduce the stress applied to brace bars affixed to the flow tubes. The driver must also drive the flow tubes to vibrate at a frequency that is higher than conventional flow tubes.

The paragraph on page 4, beginning on line 23:

A spacer is affixed to each of the manifolds to maintain the distance between the manifolds. The spacer is a structure having four [fours] sides with opposing ends affixed to the inlet and outlet manifolds. The spacer encloses a hollow cavity. This reduces the amount of material used in casting [the both] the manifold [and spacer]. Openings in the top side of the spacer allow the manifold to connect to the semicircular arc of the flow tubes which protrude outward from the spacer.

The paragraph on page 7, beginning on line 6:

In order to have reduced flag dimension, flow tubes 103A-103B have a substantially semicircular arc 150-150' between an inlet end 151-151' and an outlet end 152-152'. Substantially semicircular arc 150-150' reduces the flag dimension [since] by creating a continuous curve in flow tubes 103A-103B. Substantially semicircular arc 150-150' must be used in order to allow flow tubes 103A-103B to be

of a sufficient diameter to facilitate large flow rates of material flowing through Coriolis flowmeter 5. In order to connect flow tubes 103A-103B serially into a pipeline, inlet manifold 102 and outlet manifold 102' may have a substantially 90 degree bend in a flow path to direct flow from the pipeline into substantially semicircular arc 150-150'.

The paragraph on page 7, beginning on line 15:

To achieve zero stability and to separate vibrational modes of the flow tubes 103A-103B, a first brace bar 120 and a second brace bar 121 are affixed to flow tubes 103A and 103B. First brace bar 120 is affixed to flow tubes 103A-103B proximate inlet end 151 to connect flow tubes 103A and 103B to control oscillations of flow tubes 103A-103B. Second brace bar 121 is affixed to flow tubes 103A-103B proximate outlet end 152 to connect flow tubes 103A and 103B to control oscillations of flow tubes 103A-103B. In a preferred exemplary embodiment, first brace bar 120 and second brace bar 121 are affixed to flow tubes 103A-103B substantially 180 degrees apart from each other on substantially semicircular arc 150-150'.

The paragraph on page 7, beginning on line 24:

Driver 104 is affixed to flow tube 103A and 103B at a position on semicircular arc 150-150' that is substantially at a midpoint between inlet 151-151' and outlet 152-152' of flow tubes 103A-103B. This position allows driver 104 to apply the greatest amount of force to flow tubes 103A-103B using the least amount of power. Driver 104 receives signals from meter electronics 20 via path 110 that cause driver 104 to oscillate at a desired amplitude and frequency. In a preferred exemplary embodiment, the frequency of a vibration is substantially equal to a first out of phase bending mode of flow tubes 103A-103B which is a higher frequency than conventional Coriolis flowmeters. In order to reduce stress from the higher frequency, it is desired to maintain a low amplitude of vibration in the preferred exemplary embodiment.

The paragraph on page 8, beginning on line 2:

In order to vibrate flow tubes 103A-103B at a high frequency and low

amplitude, pick-offs [Pick-off sensors] 105-105' must be affixed to flow tubes 103A-103B at position where the greatest amount of vibration may be sensed in flow tubes 103A-103B. This allows pick-offs [pick-off sensors] 105-105' to detect the greatest amount of effect of Coriolis forces caused by the flowing material. In a preferred embodiment, the pick-offs 105-105' [pick-off sensors] are positioned at a position that is substantially 30 degrees from axes w-w'. However, the pick-offs 105-105' [pick-off sensors] may be placed at a position anywhere between 25 and 50 degrees from the w-w' axes when conventional electronics are used to drive the flowmeter.

The paragraph on page 8, beginning on line 12:

FIG. 2 illustrates a spacer 200 affixed to flowmeter sensor 10. Spacer [Space] 200 maintains a constant distance between inlet manifold 102 and outlet manifold 102'. Unlike conventional spacers in Coriolis flowmeters, spacer 200 is made of minimal material. Spacer 200 has square ends 190-191 on opposing sides. In a preferred exemplary embodiment, the square ends 190-191 are cast as square plates in manifolds 102-102'. Four walls [Walls] represented by walls 201-204 [201-202] connect each edge of square bases 190-191 to form an enclosure. Openings 210 allow substantially semicircular arcs 150-150' of flow tube 103A-103B to protrude from spacer 200.

The paragraph on page 8, beginning on line 21:

FIG. 3 illustrates a casing 300 for enclosing flow tubes [tube] 103A-103B (Shown In FIG. 1). Casing 300 is a structure having a hollow inside that fits over flow tubes 103A-103B and is affixed to spacer 200 in some manner such as a weld, or nuts and bolts. Casing 300 prevents atmosphere from entering the enclosure.

In the ABSTRACT

A Coriolis flowmeter sensor capable of handling large mass flow rates and having a reduced flag dimension. In order to have a reduced flag dimension, the flow tubes are formed to have a substantially semicircular arc between an inlet and
5 an outlet. Brace bars, connected to the flow tube proximate[,] the inlet and outlet, separate the frequencies of vibration in the flow tubes. Pickoffs [Pick-off sensors]

are positioned upon the substantially semicircular arc of the flow tube at a position that allow the pickoffs [sensors] to maximize detection of low amplitude, high frequency vibrations of the flow tubes required to have a reduced flag dimension.

In the Claims

The following represent marked-up versions of the amendments made to the claims. All of the claims are presented, amended or not, in order to avoid confusion in the event of future prosecution.

1. (Amended) A Coriolis flowmeter having a reduced flag dimension comprising:

a first flow tube having an inlet end and an outlet end, said first flow tube forming a semicircular arc between said inlet end of said first flow tube and said outlet end of said first flow tube;

a second flow tube having an inlet end and an outlet end, said second flow tube forming a semicircular arc between said inlet end of said second flow tube and said outlet end of said second flow tube;

[a substantially semicircular arc between an inlet end and an outlet end of each of said first flow tube and second flow tube;]

a driver affixed to said first [and said second] flow tube at a point on said [substantially] semicircular arc of said first flow tube that is substantially perpendicular to a bending axis [axes] of said first [and said second] flow tube, said driver also affixed to said second flow tube at a point on said semicircular arc of said second flow tube that is substantially perpendicular to a bending axis of said second flow tube, wherein said driver oscillates said first flow tube and said second flow tube in opposition to each other;

a first brace bar affixed to said first flow tube proximate said inlet end of said first flow tube and affixed to said second flow tube proximate said inlet end of said second flow tube;

a second brace bar affixed to said first flow tube proximate said outlet end of said first flow tube and affixed to said second flow tube proximate said outlet end of said second flow tube; and

pick-offs [pick-off sensors] affixed to said first flow tube on said substantially semicircular arc of said first flow tube and said second flow tube on said substantially semicircular arc of said second flow tube [tubes] in a position that allows said pick-offs [pick-off sensors] to detect the greatest amount of Coriolis force at a low amplitude vibration.

2. (Amended) The Coriolis flowmeter of claim 1 further comprising:

an inlet manifold affixed to said inlet end [ends] of said first flow tube and said inlet end of said second flow tube to affix said first flow tube and said second flow tube to a pipeline.

3. (Unchanged) The Coriolis flowmeter of claim 2 further comprising:

a substantially 90 degree bend in a flow path through said inlet manifold.

4. (Amended) The Coriolis flowmeter of claim 1 further comprising:

an outlet manifold affixed to said outlet end [ends] of said first flow tube and said outlet end of said second flow tube to connect said first flow tube and said second flow tube to a pipeline.

5. (Unchanged) The Coriolis flowmeter of claim 4 further comprising:

a substantially 90 degree bend in a flow path though said outlet manifold.

6. (Amended) The Coriolis flowmeter of claim 1 further comprising:

an inlet manifold affixed to said inlet end [ends] of said first flow tube and said inlet end of said second flow tube to affix said first flow tube and said second flow tube to a pipeline;

5 an outlet manifold affixed to said outlet end [ends] of said first flow tube and said outlet end of said second flow tube to connect said first flow tube and said second flow tube to said [a] pipeline; and

a spacer affixed to said inlet manifold and said outlet manifold to maintain a fixed distance between said inlet manifold and said outlet manifold.

7. (Amended) The Coriolis flowmeter of claim 6 wherein said spacer comprises:

an inlet end affixed to said inlet manifold;
an outlet end affixed to said outlet manifold;

5 a top side, a bottom side, a front side, and a back side each extending between said inlet end of said spacer and said outlet end of said spacer to form a rectangular body [ends]; and
openings through said top side of said spacer through which said first flow tube and said second flow tube are affixed to said inlet manifold and said outlet
10 manifold.

8. (Unchanged) The Coriolis flowmeter of claim 7 further comprising:

a casing that encloses said first flow tube and said second flow tube affixed to said top side of said spacer.

9. (Amended) The Coriolis flowmeter of claim 8 wherein said casing comprises:

a front side wall;
a back side wall; and

5 a mass affixed to said front side wall and said back side wall to change [changes] vibrational modes of said casing [housing].

10. (Amended) The Coriolis flowmeter of claim 1 wherein said position of said pick-offs [pick-off sensors] is substantially 25-50 degrees from said bending axis [axes] of said first [and said second] flow tube and said bending axis of said second flow tube.

11. (Amended) The Coriolis flowmeter of claim 10 wherein said position of said pick-offs [pick-off sensors] is 30 degrees from said bending axis [axes] of said first [and said second] flow tube and said bending axis of said second flow tube.